PROPOSAL FOR THE STUDY AND DEVELOPMENT OF A MINIATURIZED HAND-POWERED ELECTRICAL GENERATOR

15 May 1952

SECRET
SECURITY INFORMATION

PROPOSAL FOR THE STUDY AND DEVELOPMENT OF A MINIATURIZED HAND-POWERED ELECTRICAL GENERATOR

Reference A: Task Outline for HG-1 Hand Generator, No. 2056-52-10.

I. INTRODUCTION.

The Government has requested [redacted] to present 50X1 a proposal covering a program of research and development devoted to achieving a successful production prototype design for a hand-powered electrical generator approximating the Signal Corps type GN-58-A in electrical output characteristics but having approximately half of the weight and volume required by the GN-58-A equipment. The specific requirements outlined in Reference A have been abstracted:

Output Rating: 425 $\pm$25 volts at 100 ma; 105 volts at 22 $\pm$2.5 ma; 6.3 $\pm$0.1 volts at 2.4 amps; 1.4 volts at 0.3 $\pm$0.02 amps.

Voltage Regulation: The generator shall have rated test loads of 0.125 amps on the high voltage winding and 2.75 amps on the low voltage winding when tested for voltage regulation/load, voltage regulation/speed, low-voltage change with change of temperature, and ripple voltage.

With the generator operating at a cranking speed of 60 rpm under rated test loads, the high voltage shall not deviate more than 8% from its full-load test value when the low voltage load is removed.

With the generator operating at a cranking speed of between 50 and 70 rpm inclusive, and under rated test loads, the output voltage shall not deviate more than $\pm$2% from the values obtained at 60 rpm.

SECRET

With the generator operating at a cranking speed of between 50 and 70 rpm inclusive, under rated test loads and at any ambient temperature between -40 to +165°F, the low voltage shall not deviate more than 2% from the value measured under the same load at normal cranking speeds at room temperature.

With the generator operating at a cranking speed of 60 rpm under rated test loads at any temperature between -40 and +165°F, the rms ripple voltage shall not exceed 1% of either the high or low output voltage when tested for voltage regulation/load.

Electrical Noise: The generator shall have adequate filtering and shielding against conducted and radiated electrical noise. The residual noise remaining shall be no greater than, and preferably less than, that from the GN-58-A hand generator.

Mechanical:

Life: 300 hours without repair, adjustment, or lubricating. This shall not be construed as life expectancy but rather as a minimum functional requirement.

Preservation: Shall be water-immersion proof, tropicalized, including fungus resistant.

Strength: Shall be sufficiently rugged to withstand vibration and the bouncing and shock of rough handling.

Acoustic Noise: The acoustic noise produced by the generator when cranked at rated speed under a high voltage load of 0.05 amp and a low voltage load of 2.4 amps shall be less than a sound level of 57 db at 70 db weighting and 54 db at 40 db weighting when measured in a room having an ambient noise level of not more than 40 db with a sound level meter (General Radio Company type 759-B or equivalent) whose microphone is at a distance of 3 ft. from the top front of the generator.

Physical: The size of the equipment is to be reduced as nearly as possible to 250 cubic inches. (Complete generator unit in outside case only.)

Weight: It is desired to reduce the weight of unit (less cranks, stand, or tripod), if possible, to 10 pounds.

Reference A suggested that the proposed work be divided into a study phase and a design phase; the first phase would be a theoretical study with the object of determining the feasibility of building a model within the desired limits. A comprehensive engineering report of this study phase would be required. In addition to proof of the degree of feasibility, the study phase engineering report would include the following:

1. Estimates of unit cost of the manufactured item;
2. An artists sketch showing form-factor, and configuration;
3. Size and weight estimates;
4. An estimate of the physical manpower output required;
5. Electrical diagrams and circuit description.

It was then suggested that the design phase be divided into three periods as follows:

Period 1: During this period, a preliminary paper design of the unit would be accomplished, based upon the results of the study phase and aimed at producing a set of drawings and specifications for the construction of an engineering model. Preliminary tests of components or sub-assemblies of the final unit would be conducted during this period to verify their suitability for the application. At the conclusion of this period, the resulting design and data would be checked and evaluated by representatives of the Government.

Period 2: During this period, an engineering model would be constructed and complete tests performed in accordance with the specifications. These tests would be witnessed and/or reviewed by representatives of the Government. Satisfactory completion of the specification tests would precede submission of the model to the Government for preliminary operational tests at Government operated laboratories.

Period 3: Upon completion of Government operational tests, the Government might require changes or modifications in the equipment prior to production. During this period, the desired changes or modifications would be transmitted in writing to the contractor and incorporated in the design of a production prototype. All design changes necessary to achieve a design suitable for mass production would be accomplished at this time and a set of manufacturing drawings and bill of material completed. Working from these drawings, five production prototype models meeting the specifications would be built and delivered to the Government.

Proposal starts Here

While [redacted] desires to undertake a program of the general nature outlined above, existing commitments of the engineering staff to other high-priority Government-sponsored programs is too great to allow undertaking the presently requested research and development program in as broad a manner as that outlined in Reference A. The following proposal, therefore, is submitted to cover an alternative program of reduced scope designed to achieve a usable interim solution to the problem of obtaining a miniaturized hand-powered generator equipment and to provide a background of knowledge and experience which may be employed in a future program to achieve a final, more nearly optimum design for a small, light-weight equipment. 50X1

For the present, it is desired to limit the program to effecting a complete redesign of the GN-58-A equipment around the existing basic generator or a smaller commercially available equipment, such as the G-39 GN-39. While it is recognized that the generator now employed in the GN-58-A equipment is both larger and heavier than would appear to be necessary in view of present-day developments, it is felt that a very considerable reduction in size and weight of the overall equipment can be achieved without a basic generator redesign. On the other hand, efforts to produce a new generator design of significantly reduced size and weight must of necessity require a separate program of considerable magnitude. It may well appear that the generator redesign program, when undertaken, can be accomplished best by coordinating the activities of several sub-contractors.

After examining a GN-58 generator equipment loaned by the Government for this purpose, the staff of [redacted] feel that this device 50X1 can be reduced in size to approximately 60% of its present dimensions and in weight to between 60% and 70% of the present 23 pounds. These figures are based on employ-ing the presently existing basic generator now used in the GN-58-A equipment.

In accordance with the foregoing alternative plan, [redacted] 50X1 [redacted] proposes to undertake the program of research and development outlined below: 50X1

II. PROPOSED PROGRAM.

A. Electrical Redesign:

1. The filter space requirements can certainly be reduced through ordinary repackaging techniques but other savings are possible. Capacitor manufacturers will be approached both on the possibility of repackaging filter components in groups and the practicality of employing the new capacitor dielectrics, including tantalum electro-lytics. ? Recent developments in dielectric materials indicate that considerably smaller and lighter units can now be achieved with adequate breakdown voltages.

2. The filter inductors will be reduced in size and weight through the use of high-permeability cores of powdered magnetic materials.

3. A thorough examination of the basic filter requirements will be made in order to allow selection of capacity-to-inductance ratios

Declassified in Part - Sanitized Copy Approved for Release 2013/08/14 : CIA-RDP78-03424A000400080009-2

to achieve minimum filter volume. Measurements may reveal that frequency components in the generator output noise are such that a "static plate" or distributed-inductance capacitor is the most efficient high-frequency hash suppressor.

4. The output plug and its associated wiring will be greatly reduced in size. Sufficient current-carrying capacity and adequate voltage creepage paths can be maintained in 50% of the present volume required for this component.

5. Consideration will be given to the use of an alternating current 6.3 volt output. In such a design, the d.c requirement would be met with a small selenium rectifier. Such a rectifier is usually required externally to the generator to assure a constant load current when employing the equipment with any one of a variety of radio equipments. It is possible that, if the 6.3 volt output is required to provide filament current only to conventional heater-type electron tubes which operate normally on either a.c or d.c, the selenium rectifier need be used only in providing the 1.4 volt d.c output. The substitution of slip-rings for the present low-voltage commutator arrangement of the GN-58-A generator would reduce the comparatively high frictional losses now present in this portion of the equipment and probably allow recovery of enough space to contain the selenium rectifier.

6. Voltage regulation by means of thermistors and saturable reactors will be considered as a means both of decreasing size and improving life and reliability as compared to the presently-employed, solenoid-actuated regulator.

B. Mechanical Redesign:

1. Speed Gear

In attempting to reduce the size and weight of the presently existing speed gear and to increase its efficiency, theoretical and experimental consideration will be given to several possibilities including the following:

(a) Employment of nylon, teflon and Kel-F gears and/or sprockets.

(b) The use of toothed rubber belts and sprockets. D-39, G-43

(c) Possible planetary gearing arrangements.

(d) The possibility of employing a purely metal-to-metal friction drive based on the idea of employing pre-stressed ball bearings as planetary gears. In this regard, it should be noted that a high-power, torque-converter, automobile transmission employing this principle has already been applied successfully in experimental models in England and is presently under intensive development. It appears possible that a miniaturized version of the ball-bearing, friction-coupled torque converter drive could be devised to allow the inclusion of essentially automatic generator speed control, while still allowing a considerable reduction in size and weight over the presently employed system. This possibility appears promising enough to justify its detailed study as a part of the proposed program.

2. Repackaging

A brief examination and analysis of the space utilization achieved in the present GN-58-A design indicates that a packaging efficiency of only 40% was employed. While a certain amount of the "waste" space is necessitated by the need for shock-mount oscillation clearance, a considerable portion of the present volume will be eliminated by relocation of the necessary parts and their supporting structures. As suggested above, many of these parts themselves can be reduced in size through the employment of more modern electrical methods and materials.

3. Outer Case

The lower half of the outer case of the GN-58-A equipment has been fabricated from a heavy steel stamping in order to provide a member of sufficient strength to support the weight of the operator and withstand the effort of cranking. A considerable reduction in weight will be obtained by concentrating these strength requirements in the supporting frame-work itself, through a redesign of its elements, leaving the the outer case of the generator and its associated electrical components to be fabricated from a low-density, high-strength metal. The employment of fibre-glass laminates, plated on the inside with sufficient metal to accomplish electrical shielding will also be considered. Similar comments apply to the upper half of the outer case which is presently fabricated of relatively thin pressed steel. The presently employed spring latches also appear to be unduly large and will be subject to redesign.

4. Supporting Frame and Cranking Mechanism

The presently existing operator support frame will be redesigned, in its present configuration, to allow for the use of lighter-weight materials and a more convenient folding structure. In considering these components, however, it is proposed that some consideration be given to re-examining the relationship between operator efficiency and the physical coupling between the operator and the generator. It is known that a human operator can exert greater effort over a longer period of time by employing his legs rather than his arms as a power source. During the study, a review will be made of possible methods for allowing the operator to use leg power in cranking the generator, if this can be done without endangering the operator's efficiency or safety.

During the course of performance of the work outlined above, personnel engaged on the project will pay particular attention to those factors which might affect achievement of a basically new and improved generator design, to be undertaken in the future. Where it appears appropriate, the theoretical portion of the work will include detailed consideration of such a generator design.

In performing the above outlined combined theoretical and experimental study, it is proposed to carry forward the use of mock-ups and sub-assemblies to such an extent as to allow hand fabrication of one improved prototype equipment.

At the end of the work outlined above, it is proposed to assemble, test, and submit for Government approval one such equipment, together with a complete engineering report covering the work performed and results obtained up to that time, both in achieving the interim equipment design and in considering a theoretical optimum basic generator design.

The report will also include a second proposal covering the following additional work:

1. Redesign of the interim prototype for mass production, including an appropriate set of manufacturing drawings and a bill of material.

2. Fabrication of five pre-production prototype models of the interim design, in accordance with these drawings.

3. Development of an improved basic generator having minimum size and weight and so designed as to satisfy the various future requirements revealed during the above-proposed study program.

4. Development of a final prototype design employing a new, smaller, basic generator.